Small-scale Forestry (2011) 10:1–17
DOI 10.1007/s11842-010-9123-1

RESEARCH PAPER

An Internet-Supported Planning Approach for Joint Ownership Forest Holdings

Kyle Eyvindson · Mikko Kurttila · Teppo Hujala · Olli Salminen

Accepted: 29 June 2010 / Published online: 13 July 2010

Abstract This article proposes a planning approach for private forest holdings that have more than one decision maker, e.g. a heirship group or a joint ownership between siblings. Through a case study example, we illustrate the phases of the proposed planning process and describe the communication and planning tools used in this process. The final aim is that in the future the forest planners' toolkit would include this kind of approach for rather common situations where it is not easy to reach all the owners for synchronous face-to-face planning sessions. The process started with initial telephone interviews with the forest owners. From these interviews appropriate alternative forest plans were developed. Indicators and their values from the forest plans were inputted into the Mesta internet application. The forest owners were also given guidance on how to use the program. After this they were given time to independently use the program. Once the forest owners finished the use of the program, the results were collected and analyzed. Among the alternative forest plans, one was approved by all of the forest owners. The results of trial use involving a North-Karelian forest holding were encouraging. The main benefits of the approach according to the participants were learning that there are alternatives between which to choose, and reaching a common base level of understanding holding's production possibilities for future decisions. After developing the process and technical tools further, the proposed model could serve joint ownerships over distance also in

K. Eyvindson (✉)
Department of Forest Sciences, University of Helsinki, Latokartanonkaari 7, P.O. 27, 00014 Helsinki, Finland
e-mail: kyle.eyvindson@helsinki.fi

M. Kurttila · T. Hujala
Finnish Forest Research Institute, Eastern Finland Regional Unit, P.O. Box 68, 80101 Joensuu, Finland

O. Salminen
Finnish Forest Research Institute, Southern Finland Regional Unit, P.O. Box 18, 01301 Vantaa, Finland

practice and in larger scale, and, as a result, foster owners' engagement on their own forest.

Keywords Forestry decision-support · Internet-based forest planning · Multi-criteria acceptability voting · Multi-criteria approval · Multi-criteria decision analysis

Introduction

Family forest ownership dominates in many countries. As a result, forests owned by this group having greatly varying backgrounds, interest and prerequisites towards forestry play an important role in timber supply as well as in providing non-timber forest products and ecosystem services (Butler and Leatherberry 2004; Wiersum et al. 2005). Different forest policy instruments have been targeted for these forest owners so that they would conduct actions that have been seen important for the society (Serbruyns and Luyssaert 2006). Among these policy instruments is forest planning, which can be seen as information guidance, at least if planning includes elements that promote the achievement of the goals of the society (Hokajärvi et al. 2009). However, the ability to use new or traditional forest policy tools and carry out forestry operations in practice varies greatly among the various private forest owner types (cf. Kendra and Hull 2005; Hartebrodt and Bitz 2007).

It is a surprisingly common situation that several decision makers take part in the practical decision making of private forest holdings. In Finland, for example, some 25 percent of the total of 320,000 family forest holdings with greater than 5 hectares is recorded as joint ownerships (Karppinen et al. 2002). In this article, the term joint ownership forest holdings is used. It includes holdings under administrative arrangements such as a heirship group or a joint ownership between siblings. In addition, similar situation occurs in many family forest holdings, where only one person is the actual owner of the holding, but e.g. family members actively participate to the decision making and carrying out forestry operations.

The present long-term development trends in many societies, including Finnish society, and among family forest owners impose several challenges for forest planning and guidance offered to private forest owners (Wiersum et al. 2005). For example, forest owners are urbanizing, their distance to their forest properties is increasing, they are less dependent on income from their forests and, partly as a result of these, they are less interested and experienced to carry out forestry works. All these mean that they might become alienated from their forest properties. One possibility to tackle these changes is to develop distance independent Internet-based forest planning tools (e.g. Pasanen et al. 2005) and make them easily usable and interesting to use. These kinds of tools allow the forest owners to engage in self-learning without the fear of "losing one's face" by putting "silly" questions to forestry experts. Furthermore, hypertext and multimedia may serve some forest owners' learning process even better than traditional planning environments (cf. Hujala and Tikkanen 2008). The Internet based tools allow urban people to use planning tools whenever and wherever the forest owner wants to use them. In addition, Internet planning tools

can be developed so that they are truly multi-objective, which serves owners with diverse and possibly also changing forest management goals.

On the other hand, not all family forest owners belong to the potential user group of Internet-based forest planning applications. However, as people's experiences in using Internet services increase, the population of potential users will also increase. Evidently, data networks cannot be used as the only channel of carrying out forest planning, due to the diversity among private forest owners' with their varying abilities and willingness to use data networks. Therefore, there is a clear need for tools within the planner's toolbox that can be adapted to varying planning situations with different owners (e.g. Leskinen et al. 2009).

Particularly in joint ownership forest holdings, several reasons may hamper the decision making. The owners possibly meet each others only occasionally and when they do, they may not have forest planning as the main issue. In addition, the backgrounds and objectives of the owners might be different, particularly between family generations. The former places the owners in different position in evaluating the future management of the holding and the latter makes it difficult to find a common solution without decision support. In the worst case, the management of the forest holding faces a deadlock situation; due to disagreement nothing is done. In addition, the existence of several decision makers and the non-existence of written and commonly agreed documents (e.g. forest plan) makes it more difficult to make practical decisions e.g. when the prices of timber change. Therefore, a commonly accepted forest plan and management principles may greatly help in the operational management of a jointly owned forest holding.

The objective of this article is to propose, describe and illustrate a method for forest planning in joint ownership forest holdings where face-to-face contact between forest owners and the consultant is not required. The method is illustrated by using a practical case study through a single forest holding's planning process from North-Karelia, Finland. The different tools used in and the phases of this planning process are described. In the core of the proposed approach is the Multi Criteria Decision Support (MCDS) tool used on an internet platform, and the specific case study uses a specific MCDS called Mesta (Hiltunen et al. 2009), which is used for comparing and evaluating holding-level forest plan alternatives over the Internet. Important features of the presented approach are how the use of Mesta displays the possibilities of forest use, and how the decision consultant acts via internet and telephone in the course of the process. If no single plan is agreed upon Mesta provides a framework where further online or on site negotiations can begin. In discussion, the properties of the proposed process as well as its development and application challenges are discussed.

Multi-Criteria Decision Support Process with MESTA

The Generic Idea of Mesta MCDM Application

The theoretical background of Mesta corresponds to the functional idea of *feasible region reduction methods* (see also Hiltunen et al. 2009). Feasible region reduction

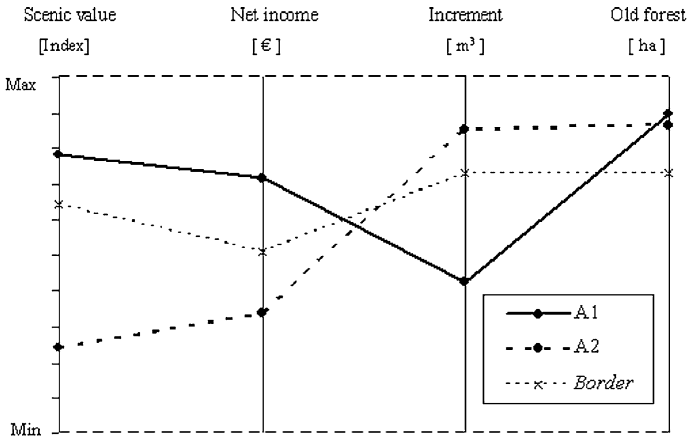

Fig. 1 The functional idea of the Mesta method. *A1* and *A2* are outcomes of alternative plans and *Border* defines the minimum wishes of the decision maker (cf. Keeney and Raiffa 1993; Pasanen et al. 2005; Hiltunen et al. 2009)

methods originate from interactive mathematical programming algorithms developed for multi-objective problems where the number of decision alternatives may be very large (Steuer 1986).

When using Mesta in a forest planning situation concerning multiple decision makers, a limited number of alternative forest plans is produced in advance. In this process, also the outcomes of the plans need to be evaluated, i.e. from each plan a value of each indicator needs to be derived. After this, the participants start individually the interactive reduction of the feasible set of alternatives by utilizing the information about the consequences of the alternatives. Mesta provides an illustrative Internet-based user interface for carrying out this task.

Mesta prompts the decision-maker to define his/her acceptance thresholds, which are the values of constraints in the feasible region reduction methods, separately for each indicator. The threshold value describes the indicator value that the decision-maker evaluates to be the limit of acceptance. Alternatives having values above the threshold are accepted; alternatives having values below the threshold are not accepted. The definition of acceptance thresholds for the indicators and the holistic performance profiles of the two alternatives (Keeney and Raiffa 1993) are described in Fig. 1.

The basic idea in the acceptance threshold definition in a case of only one decision-maker is that the decision-maker assesses and adjusts the acceptance thresholds until *one and only one* of the decision alternatives exceeds *all* thresholds (e.g. Pasanen et al. 2005). A further aim is to adjust the acceptance thresholds as long as the decision-maker understands the potential trade-offs behind the decision criteria. In particular, the decision-maker should ensure that s/he is not willing to make any further adjustments to the thresholds, i.e. the decision-maker is sure that s/he has found the alternative that best meets his/her objectives. In brief, the adjustment process can be described as follows:

(1) Assess the thresholds for each criterion so that the thresholds provide an initial estimate of the multi-objective preferences and trade-offs.
(2) The decision can be made directly if *one and only one* of the decision alternatives exceeds *all* thresholds and the decision-maker is not willing to adjust the thresholds to change the acceptance status of the alternatives.
(3) If more than one decision alternative exceeds all thresholds, the decision-maker then extends the thresholds so that eventually the conditions of Step 2 above are fulfilled.
(4) If none of the decision alternatives exceeds all thresholds, the decision-maker contracts the thresholds so that eventually the conditions of Step 2 are fulfilled.

Regarding Steps 3 and 4, it is important to note that the optimal decision alternative must exceed all the acceptance thresholds and that one must not start comparing the decision alternatives based on the number of accepted indicators. It should also be noted that the adjustments made in Steps 3 and 4 should be great enough for the acceptance status of at least one alternative to change.

The primary goal of the acceptance threshold definition process carried out with multiple decision makers or participants at the individual group member level is to produce initial preference data for the selection of the alternative that is most suitable for all individuals involved. In order to reach a commonly accepted solution, it is important that each individual participant has found at least one acceptable alternative. In the case of multiple decision makers, it may be beneficial to aim at more than one accepted alternative per person, because this facilitates the search of a commonly accepted solution. These operations aim at securing that every participant has been able to match his/her goals with the production possibilities of the planning area. With respect to the final evaluations, the more alternatives the individuals have accepted, the better are the possibilities for achieving a jointly-accepted solution. The possible strategies for finding a commonly accepted solution are described in the next chapter.

The Phases of the Planning Process for Jointly Owned Forest Holdings

The phases of the proposed decision support or forest planning process are as follows:

(1) Acquire the needed forest inventory data
(2) Interview the forest owners to clarify their goals and specific wishes. (Note, this phase may also indicate some specific demands towards inventory or stand delineation, therefore, interviews could be carried out before inventory, but on the other hand, the interview situation is better to carry out if the consultant has already some information from the status and production possibilities of the forest (see Hokajärvi et al. 2009)).
(3) Create alternative forest plans by utilizing available forest planning software. Illustrate the alternatives, as applicable, with information related to the goals and wishes of the owners.
(4) Ask the forest owners to evaluate the plans by using the Mesta tool
(5) Collect individual evaluations, and the consultant analyses them

(6) If a commonly accepted solution is found immediately, prepare the final forest plan. If not, the following options can be taken:

   a. planning consultant creates a compromise forest plan that fulfils the acceptance borders of all owners (e.g. as in Fig. 1, a plan that is slightly below the acceptance border could probably be created)
   b. a common meeting (online or face-to-face) with forest owners is arranged and they negotiate with each others by using e.g. Mesta and they are required to modify their acceptance thresholds (see Hiltunen et al. 2009) or the planning consultant interviews them separately and tries to find out possibilities to lower the acceptance thresholds so that additional alternatives become accepted
   c. the planning consultant is given a mandate to select a forest plan that is closest to the most demanding acceptance thresholds

(7) Deliver the final forest plan to the forest owners in a specified format and possible practical actions are launched.

Collecting the necessary forest inventory data is most commonly done through field measurements and aerial photography. Prior to conducting the field inventory the forest owners could be asked if there were any specific forest uses or forest resources which they would like to focus on. This may help the forest planning consultant in carrying out the field work and also, in some cases, require modifications to field work practices.

A preliminary interview is required so that forest plans can be created which will be acceptable to the individual forest owner. The interview could be conducted in person, over the telephone or through a written questionnaire or online survey. The information obtained could be used to offset a deficiency of forest inventory data. For instance the owners could be asked for spatial restrictions which could indicate areas of special importance such as scenic beauty or recreational value to the forest owner.

The information from each forest owner should be used by the planner to create a variety of plans which would have the potential of satisfying the requirements of all forest owners. It may not be possible for the planner to accommodate all of the requirements of all of the forest owners. In those cases the planner's judgement must be used in developing compromise plans which satisfy most of the forest owners requirements. These compromise plans could then be used in the negotiation phase if the forest owners do not initially agree on a single forest plan.

Once the alternative plans are created, and the appropriate data is inputted into the Mesta program, the forest owners can use the Mesta program to evaluate the plans. Prior to using the program, the forest owners should receive a detailed description of all of the alternative forest plans, where the estimated outcomes of the plans as well as differences between the plans are explained. In addition, they need instructions on how to use Mesta. This information should be enough to enable the use of Mesta, which has been planned to be easy to use for "ordinary" private forest owners.

When all of the forest owners have finished comparing the forest plans, the consultant can then analyse the results. The responses from each of the participants

would be compared, and the consultant then would suggest an appropriate course of action. If all of the participants show a preference for the same forest plans, the negotiation process is not necessary and that forest plan is selected.

If the participants did not come to an agreement during the initial process, negotiations between the participants will be required. The simplest case would be if the consultant could use the preference data obtained from the Mesta program and create a new forest plan which satisfies all of the forest owners requirements. This will not always be possible, and compromises between the forest owners' goals will be necessary. A possible method would be to have each of the forest owners to modify their preferences until one of the plans is commonly accepted. If this does not lead to a satisfactory conclusion, or the forest owners do not wish to modify their preferences, the consultant could be mandated by the forest owners to start more formal negotiations.

When a final forest plan is selected, a detailed description of the plan needs to be created and provided to the forest owners. The document usually includes information about the current state of the forest and stand level management schedules for the time period of the plan. Depending on the owners' wishes, the plan can be in electronic form (Internet forest planning software) or in a traditional paper format.

Case Study

Materials

The forest holding used in this study was a 57.8 ha joint ownership forest holding from North Karelia, Finland. This holding had four legal owners; the primary forest owner was still living near the forest holding and the other forest owners (the primary owner's adult offspring) were living in different municipalities throughout Finland, with a distance up to 450 km from the holding. One of the owners has taken the responsibility of coordinating the practical issues and makes decision proposals for the other owners. The other forest owners are typically involved only indirectly in the decision making process; the two siblings due to the distance away from the forest and the primary owner due to granting the main responsibility to her son. A forest inventory had been compiled during year 2008 by the North Karelian Forestry Centre. In this inventory, it was found that the forest holding was composed mainly of Norway Spruce stands and a fairly even age distribution of the stands. Figure 2 outlines the basic forest inventory characteristics.

In preparation for the interviews, four initial forest plans were created to represent the production possibilities of the forest holding. These plans were used as a guide for developing the questionnaires and assisting in the interviews of the forest owners. The time frame of the planning process was kept to a 10 year forest plan, consisting of two 5 year periods. This is the typical planning time frame used by the Regional Forestry Centres in Finland.

The initial four forest plans focused on optimizing a different level of cuttings:

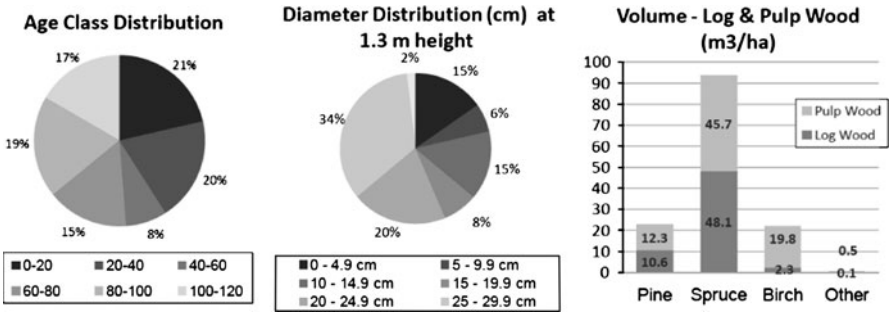

Fig. 2 Basic Forest Inventory values for the year 2009

Plan 1—Maintain sustainable even flow of cuttings. This was done by maximizing net present value, while total cutting removal and net revenues were set to be equal to or greater than the previous period.;
Plan 2—Harvest maximum amount possible during the first 5 year period;
Plan 3—Harvest maximum amount possible during the second 5 year period; and
Plan 4—Harvest only 50% of the sustainable even flow cuttings.

From these basic plans, several forest statistics were collected (Table 1).

Interviews

Introductory interviews were conducted with the forest owners in a semi-structured fashion, so that a variety of alternative forest plans corresponding roughly to the goals of each individual forest owner could be developed for use in Mesta. Prior to conducting the interview each of the forest owners were sent an introductory e-mail which described the purpose of the study and reason for their participation, a brief description of forest area, a list of the primary questions, and an aerial photograph of their forest holding.

The themes and questions of the interviews were focused on three categories:

(1) While reflecting the importance of non-wood goals, how much cutting potential do you want to utilize?
(2) What is the optimum time profile of the cuttings? Is there a large anticipated investment which would require more income in either the first 5-year period or the second 5-year period?
(3) Are there any stand-specific constraints? Is there any area or habitats of special importance to the forest owner which would limit the harvesting possibilities of these areas?

The last question was answered through the use of the aerial photograph. The forest owners were able to identify stands or areas which were of personal importance and limit the range of treatments to a particular stand. By including spatial limitations, it was hoped that important multiple-use aspects of the forest could be addressed, as

Table 1 Summary statistics for the holding according to four initial alternative plans

	Sustainable even flow cuttings		Cut all possible in first 5 years		Cut all possible in second 5 years		Cut only 50% of plan 1	
	First period	Second period	First period	Second period	First period	Second period	First period	Second period
Volume (m^3)	8,271	7,836	2,885	3,184	9,826	3,077	9,063	9,474
Cuttings (m^3)	1,482	1,482	6,396	252	23	7,415	740	740
Pine volume (m^3)	1,497	1,632	452	307	1,548	295	1,546	1,701
Spruce volume (m^3)	5,251	4,697	1,473	1,854	6,466	1,825	5,736	5,840
Broadleaf volume (m^3)	1,523	1,508	951	1,011	1,812	957	1,780	1,933
Saw Log volume (m^3)	3,442	3,165	652	777	4,249	765	3,775	3,961
Growth (m^3/y)	265	244	192	137	280	192	272	264
Log cuttings (m^3)	783	855	3,295	56	17	3,894	458	471
Stumpage price (€/y)	10,200	10,179	42,481	268	0	50,195	5,453	5,321
Net income (€/y)	11,132	11,819	45,901	0	0	55,354	8,351	8,537

the forest inventory data and the planning software used for this study did not allow for estimation or simulation of these aspects.

One of the participants (the coordinator) responded directly to the e-mail questionnaire, and for that participant a telephone interview was not conducted. Telephone interviews were conducted for the remaining three participants. The duration of the interviews was about 20 min each. The responses from the interviews showed that the forest owners held a general agreement as to the forest practices of their forest. The general consensus was to harvest slightly less than the maximum sustainable harvest from their forest. None of the participants had any requirement for an increase in the income derived from their forest. One of the forest owners wanted to shift the work of tending the forest to the second 5 year period, and two forest owners expressed a desire to limit cuttings in a few of the forest stands with special reasons that were related to scenery and mushroom and berry-picking places.

Creation of Alternative Forest Plans

A total of seven different forest plans were generated for use in the Mesta analysis. The information collected during the interviews provided significant guidance as to which forest plans would be acceptable to the owners. One of the plans was used as a reference point, where only the required and mainly pre-commercial treatments were carried out. Harvesting was carried out only to compensate for the costs of forest treatments. All of the other forest plans had gradually increased harvesting activities, with the maximum harvest being the sustainable harvest with restrictions limiting harvesting activities on a few of the forest stands.

The forest plans were generated using the MELA program (Redsven et al. 2007), which simulates the forest growth and outcomes (state of the forest stand, incomes and costs) of simulated treatments. This information is then used in the optimization

phase, where linear programming is applied in the creation of the efficient forest plans according to problem formulation. The results of each of the created plans were described to the forest owners through a variety of graphs comparing the differences between metrics selected for use within Mesta. The forest plans were optimized based on the following problem formulations:

Plan A: Only conduct the minimum cutting needed to promote good forestry practices. Additional cutting is carried out only to offset the costs of tending the forest.
Plan B: The only cuttings to be carried out are thinning harvestings; no regeneration cuttings are carried out. In the second 5 year period, the harvest is 75 m^3/year more than in the first period.
Plan C: Very little harvesting is done (175 m^3/year), and carried out evenly on both five-year periods. There are no treatments conducted in one stand.
Plan D: Harvesting is done at a sustainable level throughout the 10 year period (about 200 m^3/year). In the future, the harvesting level can be increased.
Plan E: This plan has more harvesting than plan D (about 250 m^3/year). In future periods it is still possible to slightly increase the level of harvest.
Plan F: Harvesting is done at a sustainable level during the 10 year period. The second 5 year period has 105 m^3/year more cuttings than first period.
Plan G: The maximum level of sustainable harvesting is conducted over the 10 year period. There were no harvesting operations done in one stand, and for three stands, if harvesting operations were done at least 20% of the stands' timber stock would be left as retention or scenery trees.

Values of different forest variables were calculated and imported into a matrix which highlighted the differences between the different forest plans. In this analysis, the metrics were limited to those variables which could be calculated by MELA program. As a result it was not possible to directly include variables such as biodiversity or potential for berry picking. Related variables to biodiversity and berry picking were used as a way to balance the economic variables used in the analysis. It was assumed that the stand level constraints imposed on the forest plan would be able to compensate for this limitation.

The seven indicators to be used in the multi-criteria evaluation of the plans with Mesta applications were:

1 Net income (in euros)—for the first 5 year period. Total income received from harvesting operations, less costs related to tending the forest.
2 Net income (in euros)—for the second 5 year period. Total income received from harvesting operations, less costs related to tending the forest.
3 Regeneration cutting area (in hectares)—the total area of regeneration cutting (clear cutting) during the 10 year period.
4 Total wood volume at the end of the 10 year period in 2019 (in m^3)—includes pulp and saw logs. Can be thought of as total future cutting opportunities.
5 Mature forest area at the end of the 10 year period in 2019 (in hectares)—Area of economically mature forests (over 80 years old). This increase can mean improvements to recreational activities and to the forest landscape.

Table 2 Indicator values used in MESTA for each plan

	Plans						
	A	B	C	D	E	F	G
Net income (€)	0	31,124	74,812	84,589	104,060	107,918	114,763
Net income (€)–first 5-year period	0	14,794	36,882	40,922	51,242	46,779	55,697
Net income (€)–second 5-year period	0	16,330	37,931	43,667	52,819	61,139	59,067
Total wood volume (m^3)	11,048	9,680	9,169	8,890	8,328	8,211	7,837
Broadleaf volume (m^3)	1,987	1,574	1,902	1,836	1,790	1,717	1,510
Renewal cutting area (ha)	0	0	6	7	9	9.5	9
Mature forest area (ha)	22.3	22.5	18.3	17.4	16.7	15.1	16.5
Forest area requiring tending (ha)	4.5	4.5	10.5	11.5	13.5	14	13.5
Cutting value of growing stock (€)	434,921	391,405	337,711	324,769	298,904	295,057	284,004

6 Volume of broadleaved trees at the end of the 10 year period in 2019 (in m^3)—The existence of broadleaved trees can add beauty to the forest landscape.
7 Cutting value of growing stock at the end of the 10 year period in 2019 (in euros)—This metric measures the change in wood value. It indicates the future cutting possibilities of the forest.

The indicator values in different plans can be seen from Table 2. These values were then used as an input for the Mesta program.

Acceptance Threshold Definition Process and Analysis of Results

Once the result matrix (Table 3) was imported into Mesta, it was possible to allow the owners to independently use the Mesta program. To facilitate this process, the forest owners were provided with instructions on how to use the Mesta program, an

Table 3 Indicator values for each of the seven alternatives used in the Mesta acceptance threshold adjusting task

	Participants			Mean acceptance threshold
	1	2	3	
Net income (€)–first 5-year period	*	30,734	*	30,734
Net income (€)–second 5-year period	*	30,661	35,584	33,123
Total wood volume (m^3)	*	8,724	9,026	8,875
Broadleaf volume (m^3)	1,561	1,816	1,879	1,752
Renewal cutting area (ha)	7.21	7.17	6.03	6.80
Mature forest area (ha)	17.60	16.82	17.69	17.37
Cutting value of growing stock (€)	333,336	320,182	332,333	328,617
Plans Accepted	A, B, C	C, D	C	

* Indicates that participant did not adjust this variable

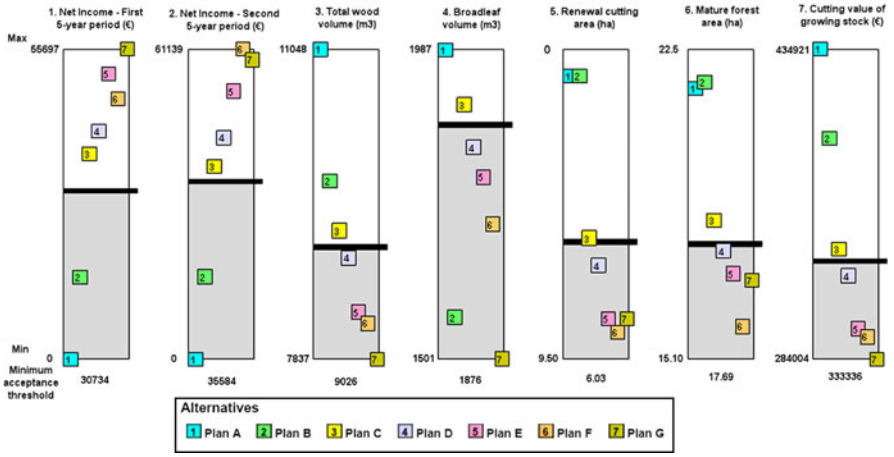

Fig. 3 The maximum acceptance threshold values of all participants, where only plan C is accepted

activated user name and password, as well as a description of all the forest plans. It was intended that the technical support as well as the personal guidance provided to the forest owners would be limited, to test the Mesta instructions and to gauge the independent usability of the program.

All of the four forest owners attempted to use the Mesta program, and three results were available for use in the qualitative analysis. One forest owner used the program and became familiar with the forest plans (the primary forest owner), but failed to save the results to the server. Of the three forest owners who did complete the program, one continued the process until only one forest plan was accepted. The other two forest owners (one of which was the coordinator) finished the program with two or three acceptable forest plans.

The results obtained from the forest owners indicated that forest plan C was acceptable to all those who completed the Mesta process. One forest owner indicated that only plan C was acceptable, another found plans C and D acceptable, and the last found that plans A, B, and C were acceptable. From these results, it was clear that plan C was the most appropriate plan for these forest owners (Fig. 3).

Feedback

After completing the Mesta task and finding the appropriate plan to fulfill the owners' objectives, feedback phone calls were performed. Each of the four owners were contacted and asked about their perceptions about the process. The following interview guide outlined the feedback discussions:

(1) Have you already familiarized yourself with the new-made forest plan?
(2) What are your feelings about the plan?
(3) How was your experience with the starting interview, alternatives and indicators (were your wishes sufficiently taken into account), and the computer (Mesta) task?

(4) What were the positive aspects of this process and what should be addressed for further development?

The owners found it interesting to learn that they generally agree upon the general forestry strategy on their holding even though they had not discussed with each other in advance. Now after the common experience they are willing to discuss more about the plan with each other, and they also assume that they will start following the plan. The coordinator noted that it will now be easier to get others to make truly joint decisions since they all have had this common learning experience.

The owners stressed that the encouraging and cozy behavior of the decision consultant (one of the authors, who had no financial interest in the decision) had a major role in making the process succeed. The wishes elicited in the starting interviews were adequately taken into account, and learning about alternatives was meaningful as was the effect of various actions for future opportunities. The illustrations (maps, figures) and the fact that the result follows their wishes make the plan appealing to be used.

Two owners considered that static timber prices behind the analysis make the result too straightforward, and they would have liked to see some analysis of the effect of raising/sinking prices on the expected outcomes or recommendations of the plan. One owner found Mesta software complicated, one said that she picked up the best plan first and then adjusted the acceptance borders so that it became selected, one found it easy and illustrative to use, and one found it a good tool to learn but proposed several usability improvements (e.g. feedback which displays a reference of the other participants responses, and more information about the scale of indicator values). The general feedback mood was positive, and the case owners would recommend this kind of a planning process for other joint ownership holdings.

Discussion

This article introduced an Internet-based decision support service intended to be used in jointly owned forest holdings' forest planning process. In the developed service, the forest owners' goals are first clarified in personal interviews and then utilized in the production of alternative forest plans. These, in turn, provide an environment where the owners can compare the outcomes of forest plan alternatives independently and without time limitations.

The final and common acceptance and selection of the plan depend on several things. If owners have very similar goals, the commonly accepted plan can be found rather easily. If the goals are very different, additional compromise plans, iterations and facilitated negotiations might be needed. In the extreme case, each individual treatment needs to be negotiated and accepted by the owners. In those cases where owners have different goals, Mesta will not be able to recommend a single forest plan. It does provide a common understanding of the tradeoffs required in order to meet particular goals, provides preference information which could be used when

developing compromise plans and should provide a framework of understanding where negotiations can begin.

The proposed interview part of the process can be carried out by e-mail, online survey, or by telephone. In this more interactive process, the owner can describe his/her objectives in more detail to the planning consultant, who can utilize this information in the creation of new forest plan alternatives. In addition, by familiarizing himself with the alternatives at the holding level, the owner may become enthusiastic about reviewing his/her own objectives and examining the suitability of the various alternative plans from the point of view of different objectives, and about studying the trade-offs between the objectives. All this is useful from the viewpoint of education and learning. Important user groups of this kind of planning software could be forest owners, who are well-acquainted with forestry matters, and private consultants who can play important roles in various stages of the planning process.

The Internet as a planning environment sets some special requirements on the planning process and the tools used. If the aim is to deliver a full-scale planning system over the Internet, the decision maker has to be able to independently manage and produce the needed information. This is why the implementation of the planning tools and methods should be made easy to understand for the forest owner. The integration of various technical planning methods with one another and with the whole planning process is a central issue (Kangas et al. 2001). Often one has to modify the basic decision-support techniques in order to meet application-specific challenges (Chen et al. 1999; Kangas and Store 2003). However, the output of the applied methods should still offer appropriate decision support for even very complex planning cases. Furthermore, forest owners are characterized by their remarkable differences in need for information and decision support. They also have their individual ways of grasping and processing information (e.g. Kolb's (1984) learning styles). These differences should be taken into account by tailoring specific planning interfaces for segmented target groups.

All decision support processes need to retain flexibility in their implementation to facilitate differences in the preferred decision styles. Decision makers who opt out or are unable to complete a specific task must be able to take part in the either the next stage of the process or be provided an opportunity in deciding upon the final decision. While non-participation is not preferable way to contribute to the decision making process, it is up to the individual to choose how s/he makes the decision. The planning coordinator should promote the use of decision support tools by explaining their usefulness and by provide clear instructions on their practical implementation. However, forcing the individual to use a decision support tool s/he does not understand is neither appropriate nor desired.

According to the participant feedback, communication of the decision consultant plays a major role in making owners engaged in this kind of a planning process over distance. This might indicate the need of particular skills for professional planners. Furthermore, starting interviews is a sensitive phase, since they essentially frame the following phases in the form of alternatives and indicators used in the comparison task. It might be so that elderly people are better served in face-to-face interviews while younger generations can be more conveniently queried over phone or web.

The feedback also indicates that owners' interest towards forestry and motivation to utilize the plan both increase when the planner shows respect of their objectives. Offering alternatives to ponder facilitates learning, which in turn leads to joint comprehension and commitment to the plan. It is evident that communication about the objectives and around alternative actions are important features when developing the present planning model further.

In this case study, the indicators available were limited by the MELA program, and the available inventory data. We did ask the forest owners if there were any additional indicators which they would like to have included, but no additional indicators were requested. The inclusion or exclusion of an indicator may prevent a proper understanding of the outcomes of the forest plan, and as a result, end in a sub-optimal choice for the forest owners. One way to minimize this is by appropriately selecting default indicators. These default indicators would just be a starting point from which the forest consultant could add or remove indicators which the participants agreed upon. While it is important to note that the indicators chosen as a default do not necessarily need to be used in the Mesta tool. Determination of what would constitute appropriate default indicators should be done in a reasoned and researched manner, as it is probable that the defaults chosen would be indicators which are most often used (Thaler and Sunstein 2008). The main idea is that they should illustrate the production possibilities of the forest holding from different perspectives.

In this study, the estimates of the different economic forest variables were based on the defaults used by the MELA program. The MELA program uses an arithmetic mean of the past 10 years (deflated to the last year) as an estimate for future prices. These estimates are well justified, and provide a reasonable forecast of the future, but some of the forest owners may be interested to gain an understanding of their own price sensitivity, and how that might affect the choice of forest plans and the utilization of the forest resources. For some users this may not be of value, and just complicate the process of using Mesta.

The benefit of the decision support approach based on Mesta is that it is suitable for situations where information required by other multicriteria analysis methods is difficult or impossible to obtain. In other words, its information requirements are low, and they are easy to fulfill: one is only required to define the acceptance borders of decision criteria. The method does not require the determination of trade-offs. The use of the method and the results it produces are also easy to adopt by the decision-maker, who (e.g. in the field of private forest planning) are often not so highly educated and familiar with decision support techniques. In addition, Mesta is suitable for group-decision support, particularly if the number of participants is high. In such cases, it is typical that possibilities for personal contact between planning consultant and participants are limited and low information requirements of Mesta are therefore advantageous.

One drawback of the method is that it does not necessarily directly produce any unambiguous recommendation as to the best alternative. There are several possibilities to resolving this problem. A simple alternative is to continue the comparison process and adjust the acceptance borders so that only one alternative is left. Also additional preference information can be requested from the decision

maker, e.g. the ranking of the criteria could be clarified as in the MA method (Fraser and Hauge 1998), and this could help in some situations. If also the relative weights of the goals and forms of sub-priority functions, which define the utility achieved from different values of goals, are available, cardinal utility models (e.g. Keeney and Raiffa 1993) could be used and relative priority values, for example, could be calculated for alternative plans. Acquiring this information would require additional preference information from the forest owners. It is notable however that when adjusting the calculations for more sophisticated decision support for the owners, the main contact and communication points of the present process will remain in their places and only the content will somehow alter.

On the other hand, the severe simplification of applications has its price, too: the decision-support value of information produced by a simple application can easily remain negligible. Web-applications may require compromises to be made between the application's versatility and its straightforwardness. Construction of sufficiently simple and user-friendly applications, while at the same time retaining the sufficient information value to achieve good decisions are among the central dilemmas encountered with IT applications. This factor may well be a bottleneck from the viewpoint of enlarging their productive use (e.g. Mahmood et al. 2000; O'Keefe et al. 2000; Kangas and Store 2003).

More research work and practical trials are still needed in the future development of the Mesta tool. In order to test the suitability of this method a study should be conducted which tests this method with a subsection of jointly held forest holdings. Attention needs to be directed towards the methods used so that balance between readily given comparison information and the usability of the application, and the quality of the produced decision support can be ensured. After refining the phases of the process model, improving the required software and conducting suitability tests with different owner groups, the approach needs to be operationalized as service products with the aid of market studies. The latter will be a responsibility of those service providers that wish to make profit serving jointly-owned forest holdings.

Acknowledgment This study was supported by the Academy of Finland (decision number 127681).

References

Butler BJ, Leatherberry EC (2004) America's family forest owners. J For 102(7):4–14

Chen WC, Hong TP, Jeng R (1999) A framework of decision support systems for use on the World Wide Web. J Netw Comput Appl 22:1–17

Fraser NM, Hauge JW (1998) Multicriteria approval: application of approval voting concepts to MCDM problems. J Multi-Criteria Decis Anal 7:263–272

Hartebrodt C, Bitz C (2007) From framework to forest activities: a comparative analysis of different ownership types in two adjacent regions. Small-Scale For 6(3):309–328

Hiltunen V, Kurttila M, Leskinen P, Pasanen K, Pykäläinen J (2009) Mesta: an internet-based decision-support application for participatory strategic-level natural resources planning. For Policy Econ 11(1):1–9

Hokajärvi R, Hujala T, Leskinen LA, Tikkanen J (2009) Effectiveness of sermon policy instruments: forest management planning practices applying the activity theory approach. Silva Fenn 43(5):889–906

Hujala T, Tikkanen J (2008) Boosters of and barriers to smooth communication in family forest owners' decision making. Scand J For Res 23(5):466–477
Kangas J, Store R (2003) Internet and teledemocracy in participatory planning of natural resources management. Landsc Urban Plan 62:89–101
Kangas A, Kangas J, Pykaäläinen J (2001) Outranking methods as tools in strategic natural resources planning. Silva Fenn 35:215–227
Karppinen H, Hänninen H, Ripatti P (2002) Suomalainen metsänomistaja(Finnish forest owner 2000), Finnish Forest Research Institute, Research Papers 852. Vantaa Research Centre, Gummerus Oy Jyväskylä In Finnish
Keeney R, Raiffa H (1993) Decisions with multiple objectives, 2nd edn. Cambridge University Press, Cambridge
Kendra A, Hull RB (2005) Motivations and behaviors of new forest owners in Virginia. For Sci 51(2):142–154
Kolb DA (1984) Experiential learning: experience as the source of learning and development. Prentice-Hall, New Jersey
Leskinen P, Hujala T, Tikkanen J, Kainulainen T, Kangas A, Kurttila M, Pykäläinen J, Leskinen L (2009) Adaptive decision analysis in forest management planning. For Sci 55(2):95–108
Mahmood MA, Burn JM, Gemoets LA, Jacquez C (2000) Variables affecting information technology and end-user satisfaction: a meta-analysis of the empirical literature. Int J Hum Comput Stud 52:751–771
O'Keefe RM, Chau PYK, Massey A, Montoya-Weiss M, Perry M (2000) From the user interface to the consumer interface: results from a global experiment. Int J Hum Comput Stud 53:611–628
Pasanen K, Kurttila M, Pykäläinen J, Kangas J, Leskinen P (2005) Mesta—nonindustrial private forest owners' decision-support environment for the evaluation of alternative forest plans over the Internet. Int J Inf Technol Decis Mak 4(4):601–620
Redsven V, Hirvelä H, Härkönen K, Salminen O, Siitonen M (2007) MELA2007 reference manual. The Finnish Forest Research Institute, Helenski, p 642
Serbruyns I, Luyssaert S (2006) Acceptance of sticks, carrots and sermons as policy instruments for directing private forest management. For Policy Econ 9(3):285–296
Steuer R (1986) Multiple criteria optimization: theory, computation and application. Wiley, New York
Thaler RH, Sunstein CR (2008) Nudge: improving decisions on health. Yale University Press, Wealth, and Happiness. New Haven, CT
Wiersum KF, Elands BHM, Hoogstra MA (2005) Small-scale forest ownership across Europe: characteristics and future potential. Small-scale For 4:1–19